GMS 7.0 TUTORIALS

UTEXAS – Embankment on Soft Clay

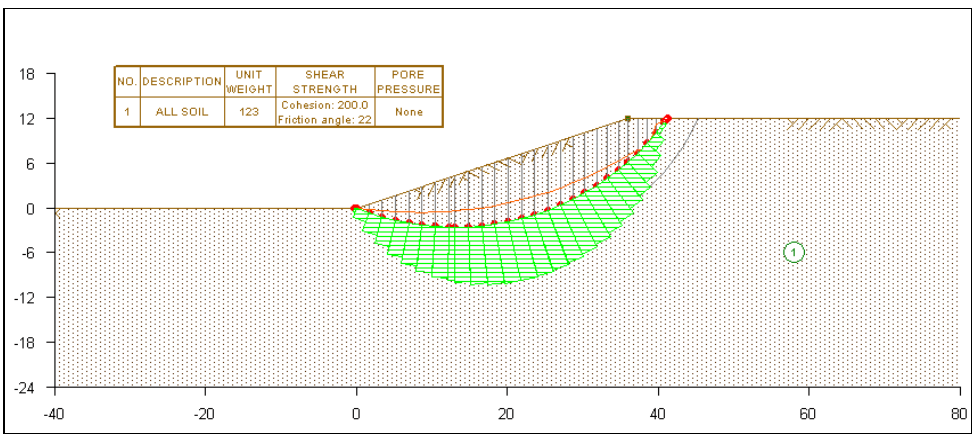


Figure 1. Sample Slope Stability Problem from the Utexam1.dat File Provided with the UTEXAS4 Software.

1 Introduction

UTEXAS4 is a slope stability software package created by Dr. Stephen G. Wright of the University of Texas at Austin. UTEXAS4 is used to analyze slope stability using the limit equilibrium method. The user provides the geometry and shear strength parameters for the slope in question and UTEXAS4 computes a factor of safety against slope failure. The factor of safety for a candidate failure surface is computed as the forces driving failure along the surface divided by the shear resistance of the soils along the surface. UTEXAS4 is a state-of-the-art slope stability code and has been widely used in industry for many years.

This tutorial illustrates how to build a simple UTEXAS model in GMS. This tutorial is similar to the Utexam1.dat sample file distributed with UTEXAS and tutorial number one in the UTEXAS tutorial manual ("UTEXPREP4 Preprocessor For UTEXAS4 Slope Stability Software" by Stephen G. Wright, Shinoak Software, Austin Texas, 2003.).

The problem is illustrated in Figure 1. A simple embankment is being modeled to determine the factor of safety and critical failure surface.

This tutorial uses the GIS feature objects in the GMS Map module to build the geometric input to UTEXAS. You should complete the *Feature Objects* tutorial prior to beginning this tutorial.

1.1 Contents

1.2 Outline

In this tutorial, we will examine different approaches for creating the input geometry required by UTEXAS4. This is what you will do:

1. Import an existing UTEXAS4 model into GMS.
2. Create a UTEXAS4 model in GMS by digitizing.
3. Create a UTEXAS4 model in GMS by typing point coordinates.
4. Assign attributes to the model and adjust the analysis options.

5. Save the model, run UTEXAS4 to get a solution, and view the solution in GMS.

1.3 Required Modules/Interfaces

You will need the following components enabled to complete this tutorial:

- Map
- UTEXAS

You can see if these components are enabled by selecting the *File* | *Register* command.

2 Profile Lines vs. Arcs and Polygons

The input to UTEXAS4 is in the form of a two-dimensional description of the soils and pore water at the site in question (i.e., a vertical “slice” or cross-section). It is assumed that the geometry is relatively constant in the direction perpendicular to the cross-section. UTEXAS4 uses profile lines to define the soil stratigraphy. A profile line is a polyline representing the top of a soil unit. Each profile line is associated with a soil id (a material id). Profile lines are defined from left-to-right, and cannot overlap.

In GMS, we don’t create profile lines – rather, we create arcs and polygonal zones from which the profile lines are later extracted automatically. For most users, it’s probably more intuitive to think in terms of soil zones than it is to think in terms of profile lines. GMS, therefore, simplifies the process of creating UTEXAS models.

For example, consider the figure below which is derived from an actual UTEXAS example and represents a dam cross section showing different zones for the shell, core, filter, riprap etc.

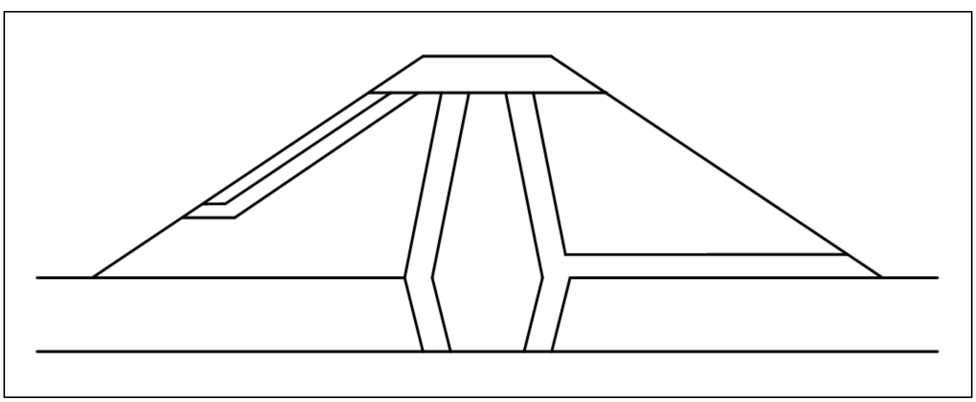


Figure 2. A Cross Section Diagram of a Dam.

The profile lines corresponding to this model are shown in Figure 3 below.

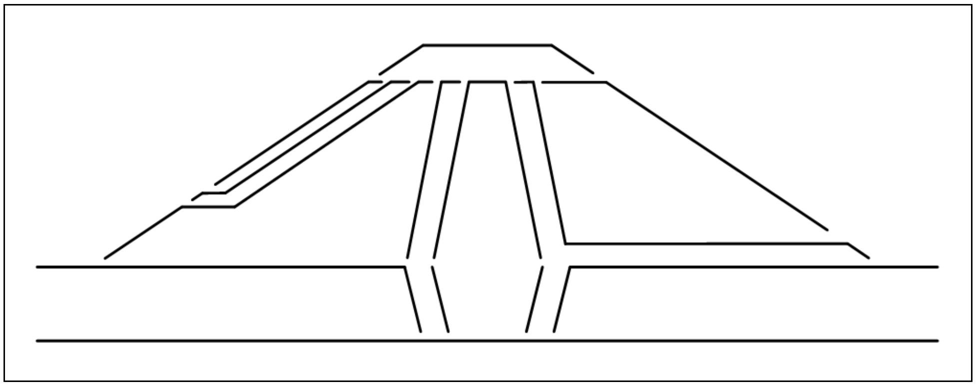


Figure 3. The Profile Lines Needed to Define the Cross Section

The profile lines in Figure 3 are shown with the lines separated at the endpoints to help illustrate where the profile lines begin and end (the actual profile lines will touch but not overlap). As you can see from this example, trying to figure out how to define the profile lines on a complex model can be challenging. In GMS, we define the model as shown in Figure 2 and GMS automatically determines how to define the profile lines.

3 Getting Started

Let's get started.

1. If necessary, launch GMS. If GMS is already running, select the *File* | *New* command to ensure that the program settings are restored to their default state.

4 Import an Existing UTEXAS Model

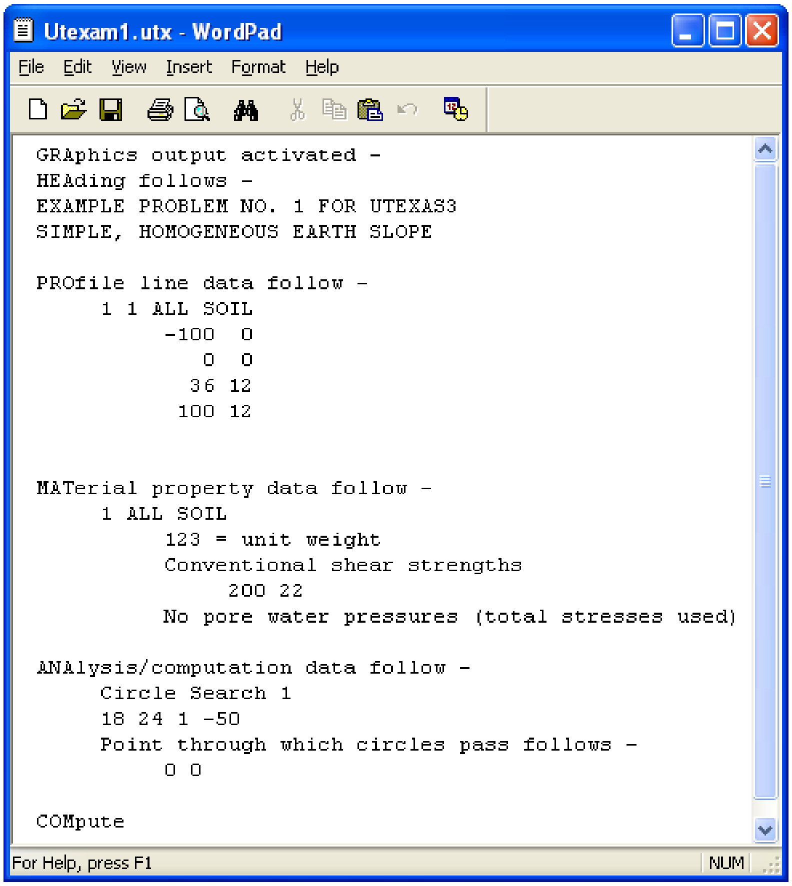
We'll first start by importing an existing model in to GMS. This model is one of the standard UTEXAS4 example problems. Later in the tutorial we will create this same model from scratch.

4.1 View the File

First let's look at the file we're going to import. It is a plain text file.

1. Select the *File* | *Edit File* menu command.
2. Locate and open the directory entitled **tutfiles\UTEXAS\embankment**.
3. Open the file named **Utexam1.utx**.
4. If GMS asks you what program to view the file with, click *OK* (the default of Notepad or Wordpad is fine).

You should now see the file as shown in Figure 4 below:




```
GRAphics output activated -
HEAding follows -
EXAMPLE PROBLEM NO. 1 FOR UTEXAS3
SIMPLE, HOMOGENEOUS EARTH SLOPE

PROfile line data follow -
     1 1 ALL SOIL
          -100  0
             0  0
            36 12
           100 12


MATerial property data follow -
     1 ALL SOIL
          123 = unit weight
          Conventional shear strengths
               200 22
          No pore water pressures (total stresses used)

ANAlysis/computation data follow -
     Circle Search 1
     18 24 1 -50
     Point through which circles pass follows -
          0 0

COMpute
```

Figure 4. Utexam1.utx file.

This file defines a simple embankment model. The file serves to both define the geometry and provide instructions to UTEXAS4 on how to analyze the problem.

5. Notice the four main sections of this file: 1) headings 2) profile lines 3) material properties and 4) analysis options.

6. Further notice that there is just one profile line which defines the embankment. The line does not form a closed polygonal area – it is simply a polyline.

Later in the tutorial we will create a model from scratch in GMS and export it. The exported file will look similar to the one in Figure 4.

4.2 Open the File

Now let's import this file in to GMS. GMS will read and interpret the file and display the embankment.

1. Close the window which is displaying the file as text.

2. In GMS, select the *Open* button .

3. At the bottom of the *Open* dialog, change the *Files of type* to **All Files (*.*)**.

4. Open the file named **Utexam1.utx**.

You should now see the embankment model as shown in Figure 5 below.

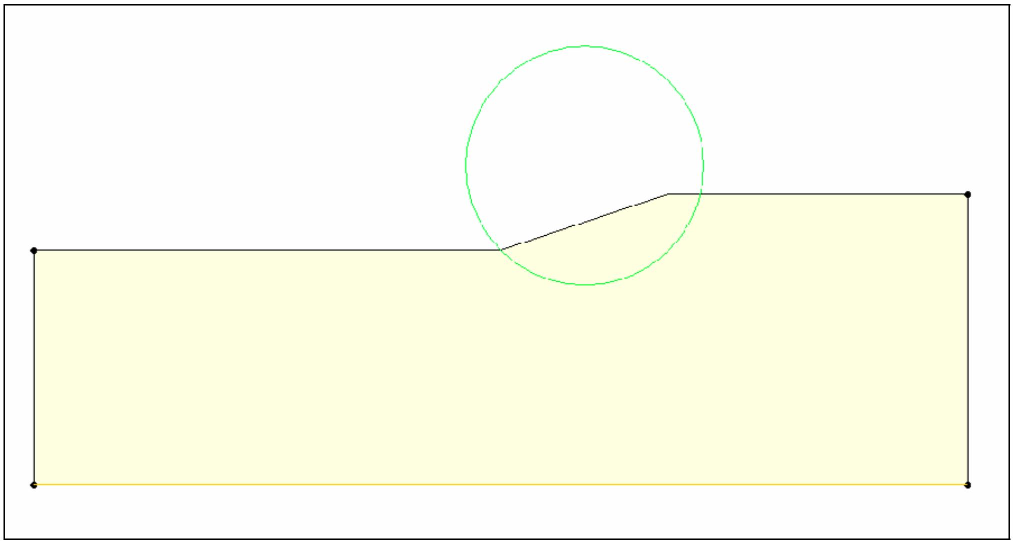


Figure 5. Embankment in Utexam1.utx file

Notice that the filled area represents the soil mass with the slope that we are analyzing. The circle is the starting circle which is used as an initial guess when finding the critical failure surface.

Notice what GMS put in the *Project Explorer*, as shown in Figure 6 below. GMS created a conceptual model called **Utexam1.utx**, a **UTEXAS** model, and a coverage named **Profile Lines**. These items define the UTEXAS simulation and will be described in more detail below.

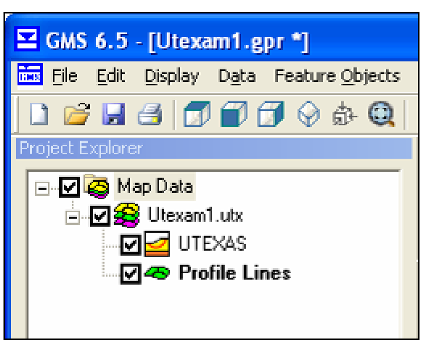


Figure 6. Project Explorer Showing the UTEXAS Model.

As you can see, if you have existing UTEXAS input files, you can import them into GMS to view and edit.

5 Save the GMS Project File

Before continuing, we will save what we have done so far to a GMS project file:

1. Select the *Save* button. This brings up the *Save As* dialog.
2. Enter a name for the project file (ex. "**embank-utexas.gpr**") and select the *Save* button.

You may wish to select the *Save* button occasionally to save your work as you continue with the tutorial.

6 Create the Embankment Graphically

Now we'll create the same model from scratch using the GMS interface.

6.1 Create the Conceptual Model

The first step is to create a conceptual model. A conceptual model consists of one or more layers called "coverages" containing GIS feature objects (points, lines, and polygons) defining the model geometry. Conceptual models can also be used to organize and manage multiple UTEXAS models.

1. Select the *New* button to delete everything and start from scratch. When asked if you want to save your changes, select *No*.
2. Right-click in the *Project Explorer* and select the *New* | *Conceptual Model* menu command.

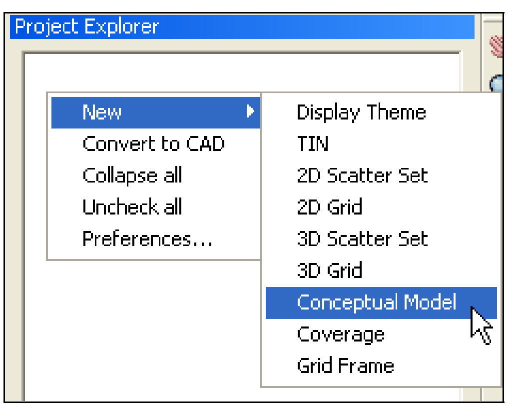


Figure 7. Creating a New Conceptual Model.

3. In the *Conceptual Model Properties* dialog, change the options as shown in the figure below and click *OK*.

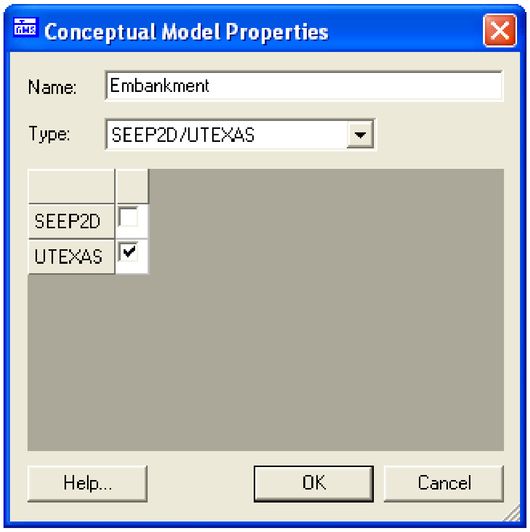


Figure 8.   The Conceptual Model Properties dialog.

After you click the OK button you should see a new conceptual model and a UTEXAS icon under the conceptual model. This icon provides access to the UTEXAS analysis options and menu commands. It is also used as a shortcut to toggle selected UTEXAS display options.

6.2 Create a New Coverage

The arcs and polygons which define the embankment must belong to a *coverage*. We'll create that coverage now.

1. In the *Project Explorer,* right-click on the  *Embankment* conceptual model you just created and select the *New Coverage* command from the pop-up menu.

2. In the *Coverage Setup* dialog, change the *Coverage Name* to **Profile Lines** and click *OK* (in this case, we don't need to turn on any properties for the coverage).

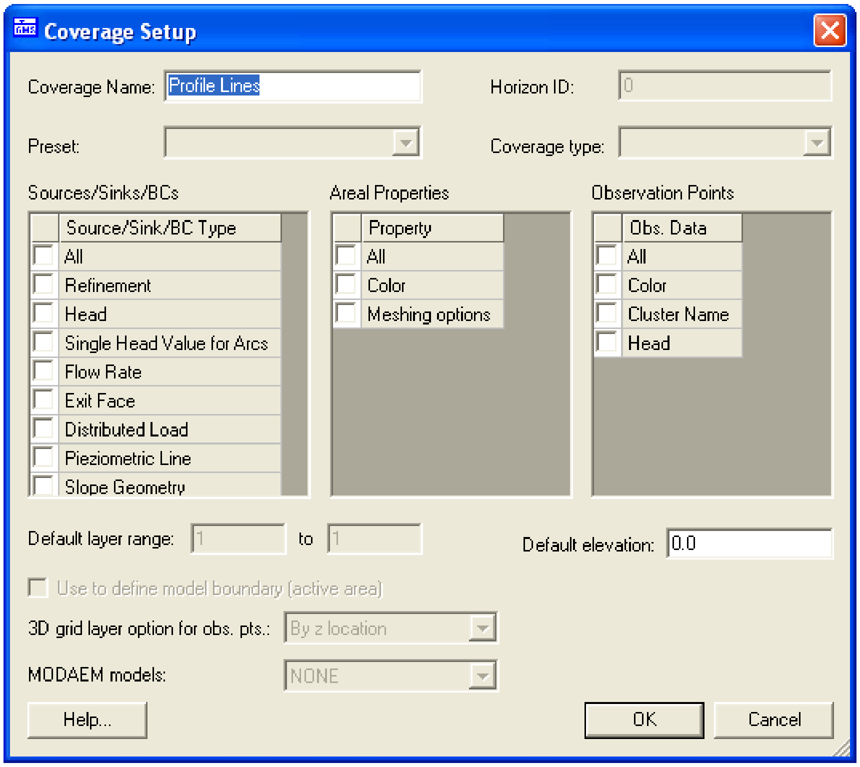


Figure 9. The Coverage Setup dialog.

3. The *Project Explorer* should now look like this:

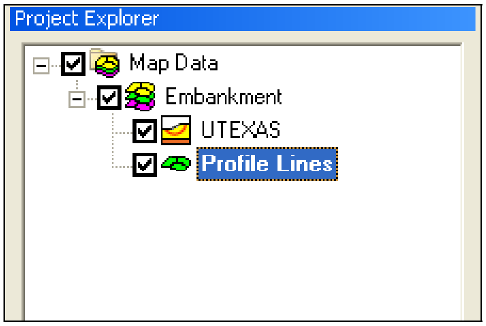


Figure 10. The Project Explorer.

6.3 Turn on Snapping

Before we draw the embankment, we'll turn on the snap option so the points we click snap to the nearest integer coordinate.

1. Select the *Display Options*  button.

2. Select the  *Drawing Grid* options in the upper left.

3. Change the *Spacing* to **1.0** and turn on the *Snap* option.

4. Click *OK* to exit the dialog.

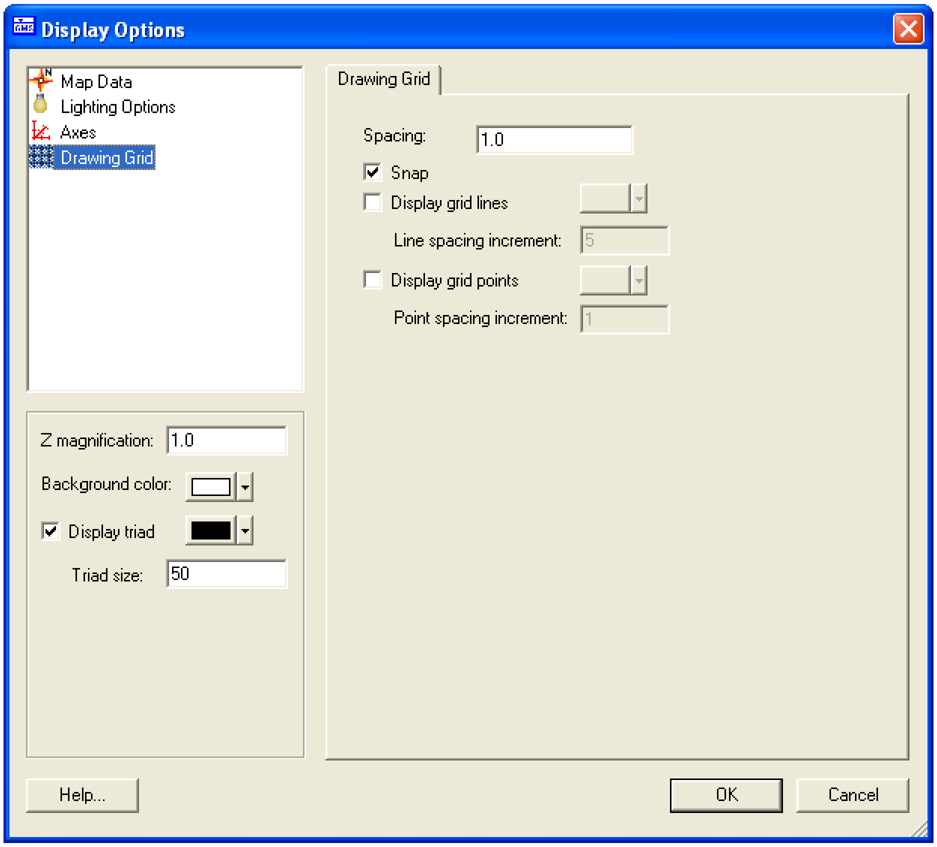


Figure 11. Turning on Snapping in the Display Options.

6.4 Set the Window Bounds

The embankment coordinates are as shown in the figure below.

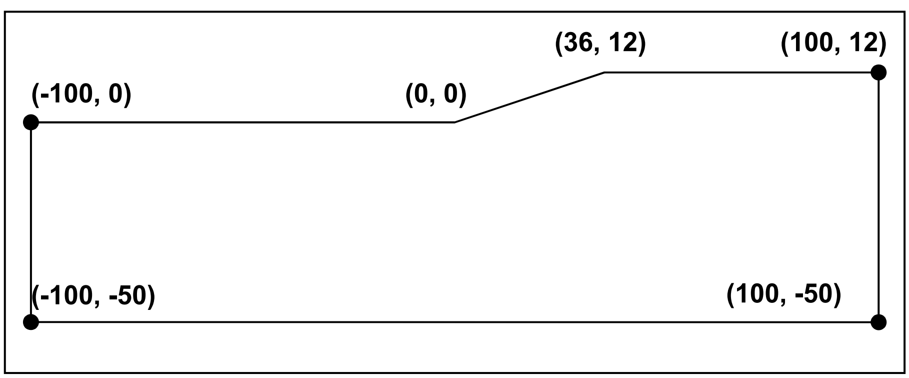


Figure 12. Embankment Coordinates.

Before we can draw the embankment, we need to set our view so that it includes this space.

1. Select the *Display* | *View* | *Window Bounds* menu command.
2. Select the first option, *X range to be specified (preserves aspect ratio)*.
3. Set the coordinates as shown in the figure below, and click *OK*.

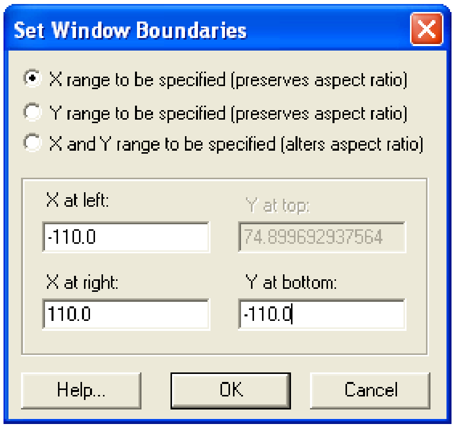


Figure 13. Setting the Window Boundaries.

6.5 Create Arcs and Polygons

Now we'll click out the arcs.

1. Select the *Create Arcs* tool.
2. Use the tracking coordinates in the bottom of the *Graphics Window* to position your mouse in the right place for each click (see the figure below).

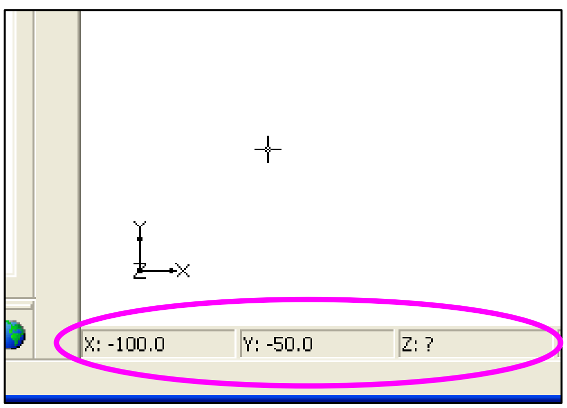


Figure 14. Tracking Coordinates.

3. Click out the two arcs shown in the figure below. Double-click to end each arc. If you accidentally click somewhere and you are still in the process of drawing the arc, you can hit the backspace key which will delete the point last clicked. If you finish the arc and there are points in the wrong place, you can use the *Select Node* tool or the *Select Vertex* tool to move the points to the correct place.

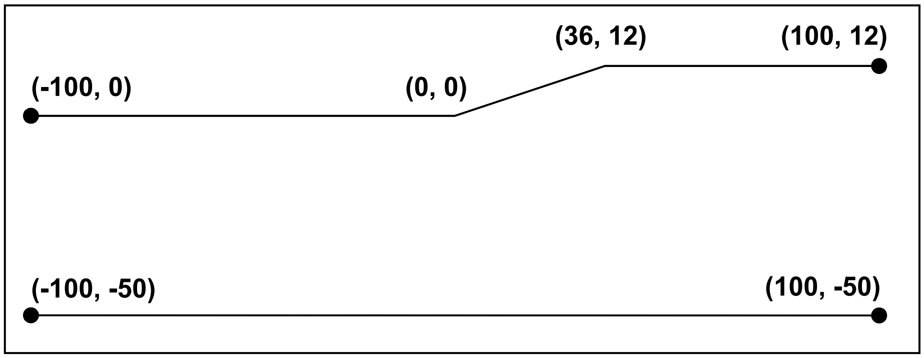


Figure 15. Drawing the Top and Bottom Arcs.

4. Using the *Create Arcs* tool, draw the vertical side arcs as shown in the figure below.

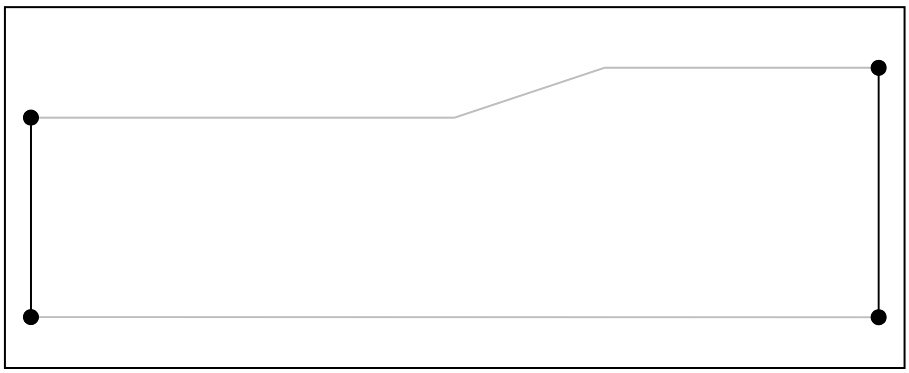


Figure 16. Drawing the Side Arcs.

5. Select the *Feature Objects* | *Build Polygons* menu command.

7 Create the Embankment by Entering Text Coordinates

Another way to define the model is to enter the coordinates directly. If you already know the coordinates of the profile lines, it may be easier to just type in those coordinates instead of clicking out the profile lines with the mouse. Or, if you already have the coordinates entered in a file, you can copy and paste them in to GMS. We'll do that now.

First we'll delete the arcs we just created.

1. Switch to the *Select Arcs* tool.

2. Select the *Edit* | *Select All* menu command to select all the arcs.

3. Hit the *Delete* key to delete all the arcs.

4. In the *Project Explorer*, right-click on the **Profile Lines** coverage and select the *Attribute Table* command from the pop-up menu.

5. Change the *Feature type* to **Points**.

6. Make sure the *Show point coordinates* option is turned on.

7. Enter the X and Y coordinates show in the table below. If you are viewing this tutorial electronically, you can copy and paste these values into the GMS spreadsheet. Don't worry about the z values. They can be left at zero since they are ignored by UTEXAS.

X	Y
-100	0
0	0
36	12
100	12
-100	-50
100	-50

8. Verify that the dialog looks like the figure below and click *OK*.

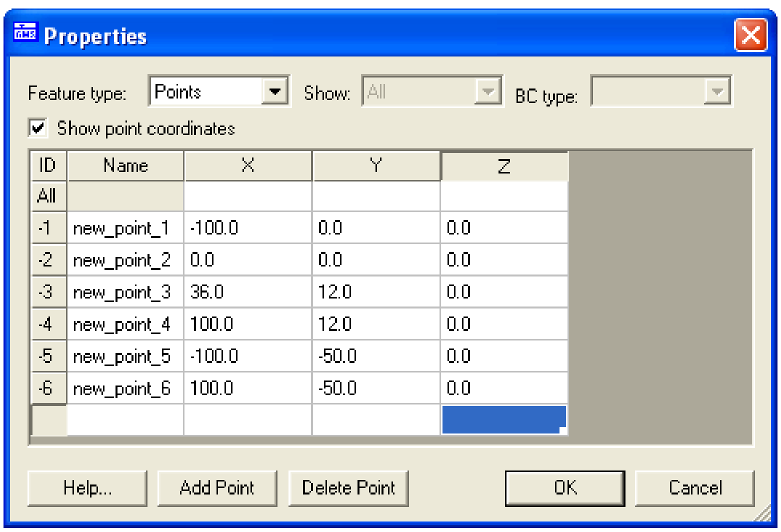


Figure 17. Typing in the Point Coordinates.

You should now see the points on the screen.

9. Select the *Create Arcs* tool.

10. Hold down the *Shift* key. This makes it so that you can create multiple arcs continuously without having to stop and restart at each point. Double-click whenever you want to stop creating arcs.

11. Click on the points to connect them with arcs to create the same embankment we had before.

12. Select the *Feature Objects* | *Build Polygons* menu command.

At this point you've seen there is more than one way to create a UTEXAS model in GMS. In the *UTEXAS – Dam Profile Analysis* tutorial, you will learn yet another way, which is to import a CAD file.

8 Assign Arc Attributes

At this point, we would normally assign attributes to the arcs. For example, we could assign a distributed load attribute representing some load on the ground surface. In this case we don't have any loads so we don't need to assign any arc attributes.

9 Material Properties

The next step is to define the properties associated with the soil material.

1. Select the *Edit* | *Materials* menu command.
2. Make sure the *UTEXAS* tab is selected.
3. Change the material properties to the following:

Unit Weight Stage 1	**Shear Strength Method Stage 1**	**Cohesion Stage 1**	**Angle of Internal Friction Phi Stage 1**
123	Conventional	200	22

4. Leave all the other settings at the defaults.
5. Click *OK* to exit the dialog.

10 Analysis Options

The only thing left to do before we save and run the model is to set the UTEXAS analysis options. We will assume a circular failure surface and will let UTEXAS search for the critical circle. We will provide the initial or starting circle by defining the circle center and a point through which the circle passes.

1. In the *Project Explorer*, right-click on the **UTEXAS** model  and select the *Analysis Options* command from the pop-up menu.
2. In the *Headings* section, enter the following headings:

   Embankment Model
   GMS UTEXAS Tutorial

3. Change the options to match those shown in the dialog below.
4. When you're finished, click *OK* to exit the dialog.

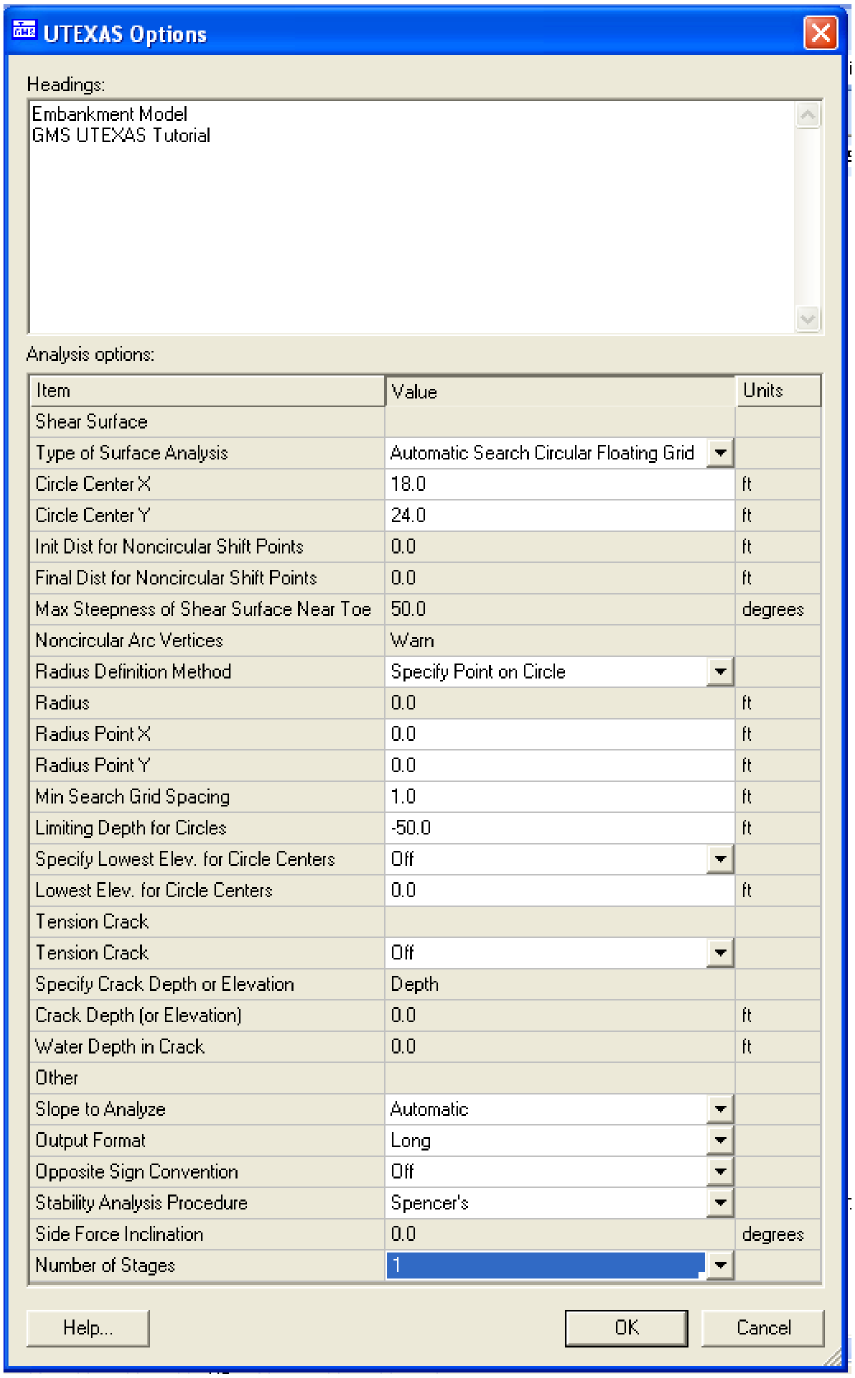


Figure 18. UTEXAS Options.

At this point you should see the starting circle displayed.

Note that while GMS supports many of the analysis options that are available in UTEXAS, some of the options are not supported.

11 Export the Model

We're ready to export the UTEXAS input file prior to running UTEXAS.

1. In the *Project Explorer*, right-click on the **UTEXAS** model and select the *Export* command from the pop-up menu.

2. If necessary, locate and open the directory entitled **tutfiles\UTEXAS\embankment** (you should already be there).

3. Change the *File name* to **embank-utexas** and click *Save*.

You have now created a UTEXAS input file called *embank-utexas.utx*. You may want to open this file in a text editor and examine its contents. You could also compare it to the *Utexam1.utx* file we imported earlier.

12 Run UTEXAS

Now that we've saved the UTEXAS input file, we're ready to run UTEXAS.

1. In the *Project Explorer*, right-click on the **UTEXAS** model and select the *Launch UTEXAS4* command from the pop-up menu. This should bring up the UTEXAS4 program.

2. In UTEXAS4, select the *Open File* button.

3. Change the *Files of type* to **All Files (*.*)**.

4. Locate the **Embankment.utx** file you just saved (in the **tutfiles\UTEXAS\embankment**) folder and open it.

5. When UTEXAS4 finishes, look at the things mentioned in the *Errors, Warnings* window, then close the window.

13 Read the Solution

Now we need to read the UTEXAS solution.

1. In the *Project Explorer*, right-click on the **UTEXAS** model and select the *Read Solution* command from the pop-up menu.

2. Locate and open the file named **Embankment.OUT**.

You should now see a line representing the critical failure surface, and the factor of safety.

14 Display Options

Let's take a look at the UTEXAS display options in GMS.

1. Select the *Display Options* button.
2. Make sure the *Map Data* item is selected in the list in the upper left of the dialog.
3. Select the *UTEXAS* tab. The dialog should appear as shown in the figure below.

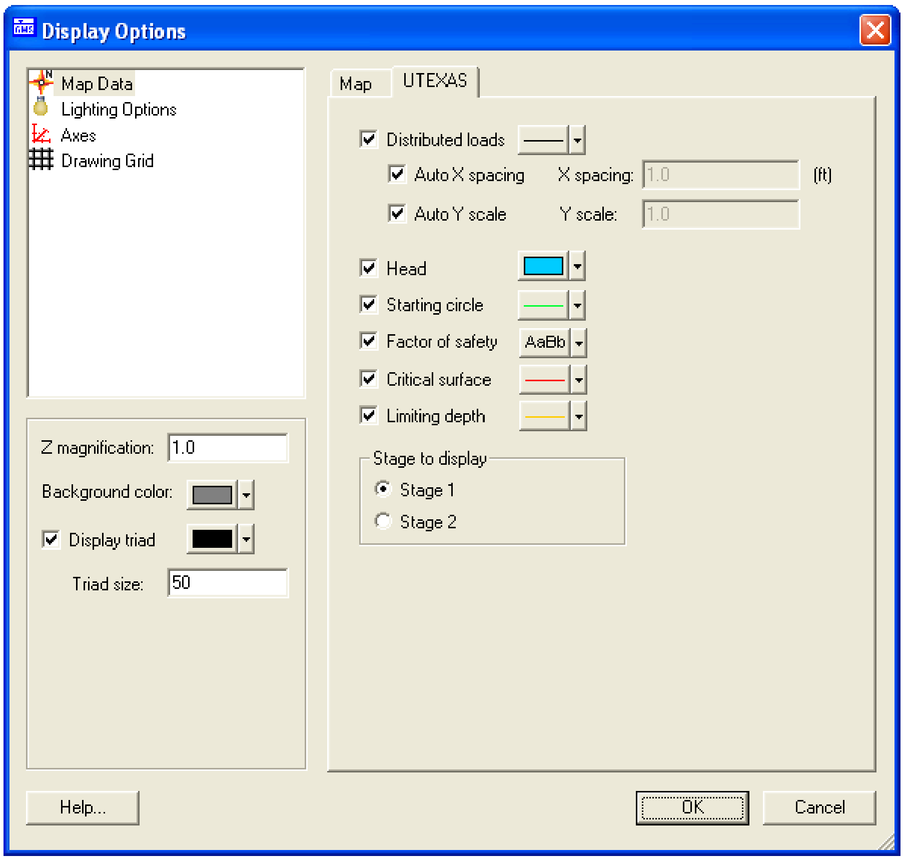


Figure 19. UTEXAS Display Options.

4. Try changing the display options and see how it affects the display.

15 Conclusion

This concludes the tutorial. Here are some of the key concepts in this tutorial:

- UTEXAS uses the profile line approach to define the model geometry, but GMS uses arcs and polygons. GMS automatically extracts the profile lines from the arcs and polygons when exporting the UTEXAS input file.
- GMS can read UTEXAS input files created outside of GMS.

- You can create a UTEXAS model in GMS by drawing the arcs, or by entering in the coordinates of the profile lines and connecting the points with arcs.

